

On the behaviour of Blue Sheep (*Pseudois nayaur*)

BY

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(With two plates, a map and two text-figures)

Blue sheep (*Pseudois*) are morphologically similar to both sheep (*Ovis*) and true goats (*Capra*). The main purpose of a brief study on a small population of blue sheep in eastern Nepal was to find out if the species is behaviourally allied to sheep or to goats. Several courtship displays and various forms of aggression, such as the methods of clashing horns, are described and quantified. And these show that blue sheep resemble goats in their behaviour.

Sheep of the genus *Ovis* can be distinguished from goats of the genus *Capra* by such physical characters as the presence of preorbital glands, interdigital glands on all feet, and the absence of a beard. The tribe Caprini, to which sheep and goats belong, also contains two genera, each represented by a single species, whose phylogenetic position remains unclear because the animals are morphologically allied both to *Ovis* and *Capra*. One is the aoudad (*Ammotragus lervia*), the other the blue sheep (*Pseudois nayaur*). In their general appearance, including the absence of a beard, blue sheep resemble *Ovis*. Males lack the strong body odor typical of goats. Furthermore, blue sheep have no callus on the knee, and the small, spindly horns of females are similar to those found in sheep rather than to the sturdy, fairly long ones that are characteristic of goats. Lydekker (1898) stated that blue sheep have interdigital glands on all feet, a sheep-like trait, but Pocock (1910) found that at least some individuals lack these glands. In other characters, blue sheep show an affinity to goats. The horns of males curve first up, then out, and finally back, like those of East Caucasian tur (*Capra cylindricornis*), and, as Lydekker (1898) pointed out, 'the structure and colour of the horns are the same as in goats'. He also found that the basioccipital bone of the skull resembled that of goats rather than sheep. Blue sheep, like goats, have markings along the anterior surface of their stocky legs, they have large dew claws, and their tail is bare underneath except at the tip. Reflecting his confusion over this combination of traits, Hodgson originally placed the species into the genus *Ovis*, but 13 years later, in 1846, switched it to a new genus, *Pseudois*. Today the blue sheep is generally considered to be an

aberrant goat with sheep-like affinities (Ellerman and Morrison-Scott 1951).

Behavioural data can usefully supplement other information in solving taxonomic problems. Knowledge about blue sheep in the wild is limited largely to general comments (Wallace 1913; Burrard 1925; Stockley 1928; Schäfer 1933, 1937; Dang 1968) and hunting accounts (Markham 1854; Fergusson 1911; Hayden & Cosson 1927). While some of these reports contain useful information, particularly those by Schäfer, none describe behaviour of blue sheep in detail. Research on sheep and goats in zoos has contributed importantly to an understanding of the Caprini (Haas 1958; Walther 1961), but, as Crandall (1964) noted, 'the blue sheep has now become extremely rare in collections'; captives have never been studied. I spent March 1 to 3 and March 9 to 19, 1972, on a wildlife survey in the upper Kang Chu Valley (86° 12' E, 28° 7' N) of eastern Nepal. Although contact with blue sheep was limited to 54 hours of observation on 11 days, my notes help to clarify the taxonomic status of the species.

The blue sheep lives in one of the most remote regions on earth. Its range stretches from Baltistan in Kashmir eastward across the Tibet province and into the Yunnan, Szechwan, Kansu, and Shensi provinces of the People's Republic of China. The Kuenlun and Altyn-tag ranges form the northern boundary of its distribution and the crest of the Himalayas the southern (Burrard 1925; Schäfer 1933). Most blue sheep in Nepal are located in the western portion, along the edge of the Tibetan plateau, but in a few localities, such as on the western and southern flanks of Mt. Dhaulagiri and along the upper Arun River in eastern Nepal, they have penetrated into the Himalayan Range (Map). The animals avoid wooded terrain, being usually found above the thickets of juniper, birch, and other stunted trees that mark timberline. Generally they occur from an altitude of about 3500 m upward to at least 5500 m (Burrard 1925), but in the eastern part of their range they may be seen as low as 2700 m (Schäfer 1937). 'In a word, what they delight in is good grazing ground in the immediate vicinity of rocky fastnesses . . .' (Kinloch 1892). This was also the case in my study area. The Kang Chu divides near the headwaters, each fork soon entering Tibet. On the Nepal side of the border, blue sheep inhabit only a small range between these forks. This range has two characteristics which make it good sheep habitat: (1) good grazing is available on the gradual lower slopes as well as on the adjacent cliffs, which, though steep, are covered with many ledges, terraces, and small plateaus in contrast to the surrounding mountains which present relatively unbroken and barren expanses of scree and rock faces; and (2) the slopes, with their southern exposure, are free of snow over a month before those on the opposite sides (Plate I, *above*). During my stay,

the blue sheep were generally low on the slopes, at an altitude of about 4000 m, in the early morning, then slowly retreated uphill as yak herdsmen became active in the valleys.

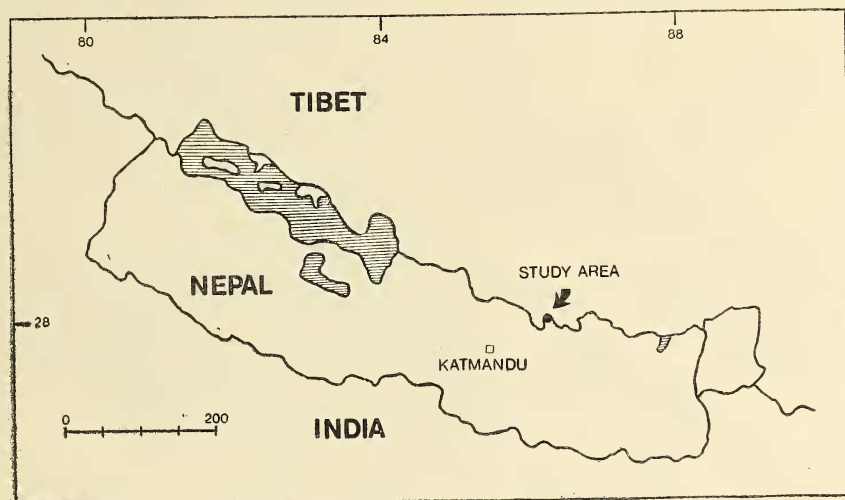


FIG. 1. The approximate distribution of blue sheep in Nepal. The distribution in the western part is not as continuous as indicated but more precise information is not available.

DESCRIPTION OF ANIMALS

Blue sheep were divided into several age and sex classes based on size, pelage colour, and, in the case of males, also on the number of horn rings which are often discernible at a distance. The descriptions below are limited to characters which I found useful for distinguishing the various classes; detailed accounts can be found in Lydekker (1898) and Schäfer (1937). The ages of males are given as they were estimated at the time of the study.

Class IV male (fully grown, at least 7 to 8 years old). Adult males are stocky animals, almost 1 m tall at the shoulders, and with a weight of as much as 60 to 75 kg (Schäfer 1937). Their winter coat is a striking slaty-blue in colour, which contrasts with their white abdomen, small white rump patch, and white insides of the legs. A conspicuous black flank stripe separates the upper from the underparts. The anterior parts of the forelegs are also black, except for the white knees, as are the anterior edges of the hindlegs, the chest, and the centre of the tail. Black streaks run along the top and sides of the muzzle. The smooth horns flare far backwards at the tips and are an estimated 60 cm or more long; Lydekker (1898) mentioned several record horns with lengths of 75 to 81 cm. The oldest ram I aged was about 9 years, but Schäfer (1937) shot one 13 to 15 years old.

Class III male (almost 5 years to almost 7 years old). Males of this class resemble class IV males except that they are slightly less heavy in build and they have shorter horns, measuring about 45 to 55 cm in length (Plate I, below).

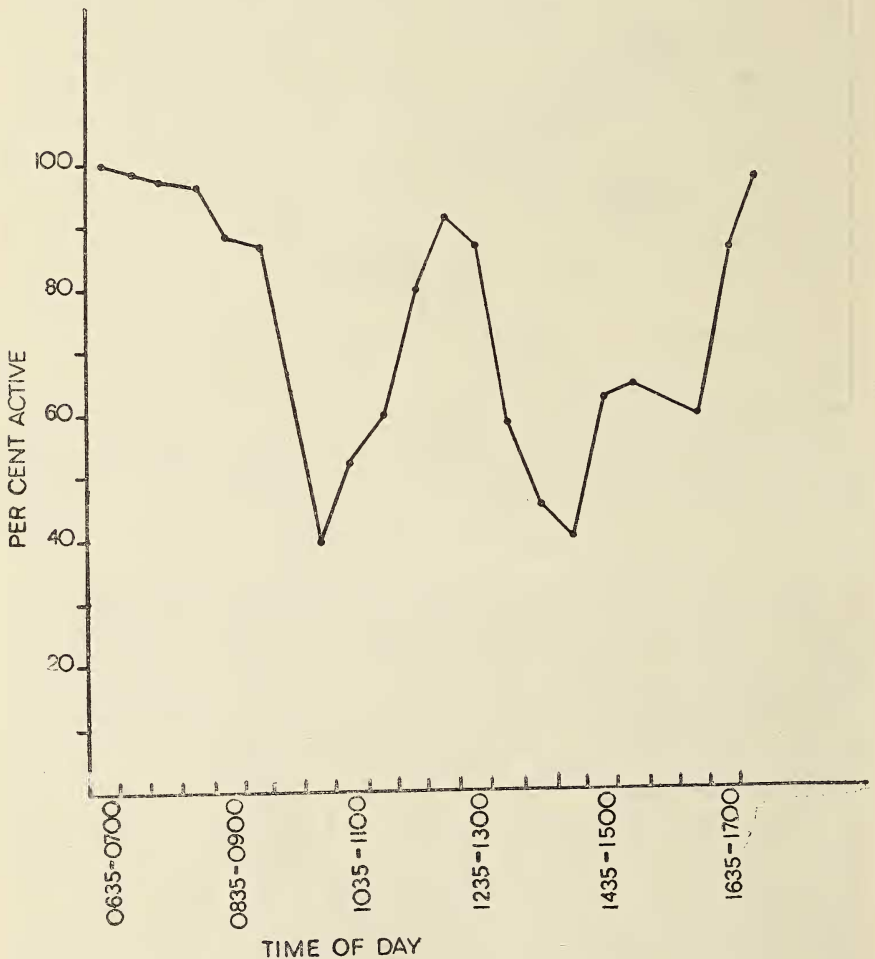
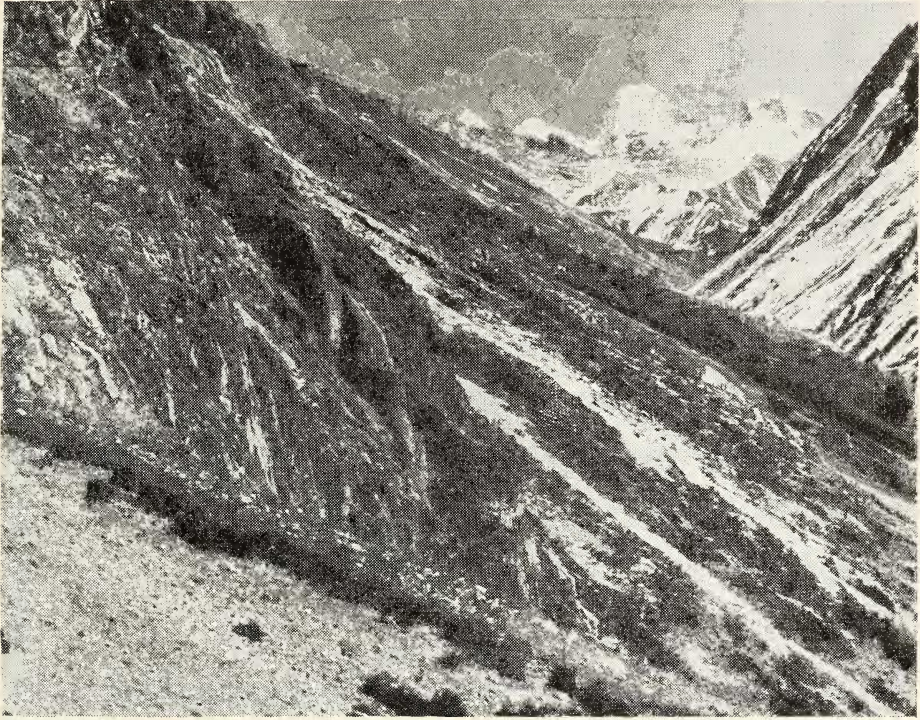


Fig. 2. Per cent of blue sheep active at various times of day, 0635 to 1730 hours.

Class II male (almost 4 years old). The flank stripe of these young adult males is either absent or only faintly visible. The horns curve up and out, but barely back, and they are about 35 cm long (Plate II).

Class I male (almost 3 years old). These subadult males are of about the same size as adult females. They lack a flank stripe, and their horns do not flare back, being only about 25 cm long.

Schaller : Blue Sheep



Habitat of the Blue Sheep in the Kang Chu area of Nepal



A Class III male, Kang Chu, Nepal

(Photos: George B. Schaller)

Schaller : Blue Sheep



Carcass of a Class II male killed by a Snow Leopard

(Photo: George B. Schaller)

Yearling male (almost 2 years old). Yearlings are two-thirds the size of adult females, and, like class I males, they lack a flank stripe. The horns are about 15 cm long.

Females. Adult females are considerably smaller than adult males, weighing only 35 to 45 kg (Schäfer 1937). Their pelage colour is similar to that of males except that it lacks the richness in hue. Lydekker (1898) wrote: 'In the females the black markings on the face, chest, and flanks wanting'. The animals I studied had dark chests and some also had black facial and flank markings. The horns are spindly and short, curving up and out. Yearling females are smaller than adult ones.

Young (almost 1 year old). Young are much smaller than yearlings and their straight horns are about 5 cm long. A woolly cap of hair covers their crown, a feature also seen in some females. Young still followed females closely even though they were weaned, judging by the fact that occasional suckling attempts were rebuffed.

POPULATION AND HERD DYNAMICS

The slopes in the study area were searched almost daily for blue sheep. At least one small herd could usually be found, often the same one in the same locality for several successive days. The highest count on any one day was 33 animals, and other known individuals raised the minimum number in the area to 48. Some blue sheep were no doubt overlooked, but it seems unlikely that there were more than 75.

I classified 216 animals, many of them repeatedly in the course of the study, and the composition of the population was as follows: class IV male 3.7%, class III male 9.3%, class II male 6.5%, class I male 10.6%, yearling male 11.1%, adult female 25.9%, yearling female 10.2%, and young 22.7%. Males of classes I to IV somewhat outnumbered adult females, but this may either be a sampling bias or the small study population, located at one end of a mountain range, may not be quite typical of the population as a whole. I suspect that the sexes in adults are represented about equally, as they are in yearlings. There were 87 young to 100 adult females, a high percentage, especially since those females that were almost 3 years old had not yet had their first young. The slim abdomens of yearlings as compared to the bulging ones of adults showed that females have their first young at the age of 3 years. The zoo data collected by Zuckerman (1953) and the observations made of free-living animals by Schäfer (1937) indicate that one young is the rule. This was also my impression. However, one female appeared to be accompanied by twins. The large number of young, was thus mainly attributable to good survival in 1971. The

fact that the yearling percentage was 21 (82 yearlings to 100 adult females) indicated that the death rate of young animals was also low in 1970.

Two or possibly three adult snow leopards (*Panthera uncia*) hunted in the study area, and their principal prey was blue sheep, as revealed by 14 food remnants in 12 droppings of various ages: blue sheep—7; yak (*Bos grunniens*) which was known to have been scavenged—1; Himalayan marmot (*Marmota bobak*)—3; grass—1; and small amounts of unidentified hair—2. Two fresh blue sheep kills were also found. A class II male walked alone to a rivulet of water in the valley and there was stalked and captured by a snow leopard. The cat disemboweled its quarry, ate a little of it, then dragged it 150 m uphill, a sequence of events clearly revealed by the tracks in the snow. After eating on the carcass for 3 days, the snow leopard abandoned the remains, principally bones and skin (Plate II). The other kill was a class III male, almost 7 years old, captured on a boulder-strewn slope. In India, Dang (1967) found 7 blue sheep that had been killed by snow leopard and of these 6 were males. Several Tibetans in the area owned coats made of blue sheep hides, but the casual way in which sheep avoided persons and the readiness with which they entered the village of Lapche when it was unoccupied during the winter suggested that the animals there were not hunted much by man.

Group structure in blue sheep, as in many ungulates, changes with the seasons. Males tend to separate from the females after the rut (Burrard 1925; Dang 1968) and form male groups which may contain as many as 40 members (Schäfer 1937). However, a few males associate with females throughout the year (Kinloch 1892). The literature is not in agreement as to when blue sheep rut, estimates varying from September (Prater 1965) and October (Schäfer 1937) to October–November (Stockley 1928) and January (Wallace 1913). However, most authors agree that young are born between April and June, which, if a gestation period of 160 days (Crandall 1964) is accurate, would place the main rut into November and December. My observations were made after the rut was over and during a period of transition when males were in the process of leaving the females.

Group size may vary from 2 to 200 (Stockley 1928) and even 400 (Schäfer 1937). The largest group I saw numbered 22 animals, and the average of 18 group counts was 11. Schäfer (1937) found that during October an average group was composed of about 5 males of varying ages, 10 yearling and adult females, and 5 young. Dang (1968) gave the composition of one large group, and it contained 14 males, 23 females, and 19 young. The blue sheep in my study area seemed to be divided into about 3 main herds, each occupying certain slopes. Schäfer (1937) also noted that herds have preferred ranges. Herds

changed composition constantly as single individuals and groups joined or parted. For example, one group consisting of 1 yearling male, 1 class I male, 1 class III male, 3 females, and 3 young was joined in the course of a morning by a solitary class I male, a group of 3 adult males (2 class III and 1 class IV), and a female with young. Another time a group of 15 animals split into groups of 10 and 5 as each moved foraging into opposite directions. All groups numbering 8 or more animals contained at least one subadult or adult male. One group of 22 blue sheep was, for instance, composed of 2 yearling males, 3 class I males, 1 class II male, 2 class III males, 2 class IV males, 3 yearling females, 6 adult females, and 3 young. But associations between males and females were obviously tenuous. Adult males often gathered at the periphery of the group, rested together some 20 m from it, and sometimes left it alone or in twos and threes. Solitary males of all ages, except yearlings, were seen.

GENERAL BEHAVIOUR

Daily activity patterns, food habits, and other aspects of ungulate behaviour are influenced by the seasons. It was late winter in the upper Kang Chu when I was there. The average daily minimum temperature was -4°C (-8 to -2°C), and the average daily maximum was 7°C (5 to 10°C), but the winds that howled off the Tibetan plateau in early morning made it seem colder. Over 0.6 m of snow fell on March 5. By March 10 the sun had exposed about half of the sheep range, and a week later most snow was gone from the lower slopes. Up to 5 cm of snow also fell on March 13, 16, and 17 but melted the same day.

Blue sheep had mainly dead vegetation available as food, although in mid-March a few green shoots began to appear. Grasses (*Festuca* sp., *Trisetum* sp., *Danthonia schneideri* and others) were by far the most important food of blue sheep. A legume (*Thermopsis barbata*) was commonly eaten, and other dry forbs (an Umbelliferae, a *Polygonum*) and ferns also contributed to the diet; one animal ate the everlasting flowers of *Anaphalis contorta*. Sheep also browsed on *Juniperus* tips and on leaves of various shrubs, including *Berberis* sp., *Cotoneaster microphyllus*, and *Ephedra gerardiana*. Several animals appeared to lick crustose lichens off rocks. The rumen contents of a blue sheep killed by a snow leopard showed the importance of grass in the diet: an estimated 98% by volume was dry grass, and the rest was *Juniperus*, *Berberis*, *Ephedra* and *Thermopsis*.

A group spent most of the daylight hours feeding on dry, snow-free sites, sometimes scattered over the slope, at other times concentrated in a small area. Burrard (1925) and Schäfer (1937) reported that blue

sheep feed mainly in the early morning and late afternoon, whereas Lydekker (1898) noted no particular schedule. To find out if blue sheep have a feeding routine, I recorded the number of active and resting animals every 5 minutes. The 6 points in each half-hour period were combined and expressed as per cent of animals active in Figure 1, which is based on 8883 activity observations. At least 40% of the sheep were moving or feeding at any one time between 0635 and 1730 hours, but there were activity peaks before 0930 hours, between 1130 and 1300 hours, and after 1635 hours. Even during rest periods one or more members of a group were usually foraging. Occasionally one pawed the ground 2 to 6 times before eating items which I could not identify. Such pawing may also occur on rare occasions before an animal lies down. Blue sheep rest either with legs tucked beneath them, or with one or both forelegs stretched forward. Choice of rest sites seemed fairly haphazard as long as the ground was dry, a ridge top, an outwash plain, the depth of a ravine, without reference to sun, wind, or visibility. I found no evidence to support Kinloch (1892), Fergusson (1911), and others who claimed that blue sheep have sentries. However, the fact that at least one animal was usually moving around made it difficult to venture close to a group undetected. Domestic yak were not avoided, the two species sometimes being within 10 m of each other, but the slow approach of a person from the valley caused blue sheep to walk or run uphill. Sometimes an animal halted and stamped a forefoot as it alertly peered down at the source of danger. Many authors have reported that blue sheep also give sharp whistles in such circumstances. When disturbed, an adult female usually led the retreat of a large group. This was the case in 9 out of 10 instances observed, the exceptional leader being a class III male.

COURTSHIP DISPLAYS

I did not observe courtship behaviour except for a few isolated displays. These are described here so that they may contribute to a later discussion of the evolutionary affinities in the behaviour of blue sheep.

Lip-curl. On 3 occasions a class III male sniffed the anal area of a yearling female and then raised high his muzzle with the upper lip curled, a means of testing by olfaction whether a female is in estrus. A yearling male placed his nose into the stream of urine of a young, lip-curling, then butted the youngster in the rump.

Low-stretch. A class III male approached a yearling female from behind with his neck held low and horizontally and with his muzzle raised. His tongue flicked in and out of his mouth, and afterwards he once kicked the female. On another occasion a class IV male

displayed the low-stretch to a yearling female. A gesture termed the twist, with the animal turning its head so that the horns point away from the other animal, is often given in conjunction with the low-stretch by *Ovis* and *Capra*. This display was not observed in blue sheep, but further research may reveal it.

Kick. A young moved slowly, alternately stopping and walking as it fed, closely followed by a class III male. Four times the male sniffed the spot where the young had stood. Suddenly he stepped behind the young and kicked once with each foreleg. Another instance of kicking is described above. The kicks were gentle, with the foreleg bent limply at the carpal joint and lifted no more than 15 cm off the ground; the leg did not touch the other animal.

Inserting penis into mouth. A class III male stood at the edge of a group, slightly lowered his rump, turned his face toward the groin, and inserted his erect penis into the mouth. He kept it there some 6 to 8 seconds and seemingly sucked it. Another class III once licked his erect penis.

AGGRESSIVE BEHAVIOUR

The aggressive patterns of *Ovis* and *Capra* are in several ways distinctive. Consequently the combat methods of blue sheep can probably reveal more about the phylogenetic position of the species than other forms of behaviour. The literature is devoid of useful information on this topic except for one intriguing statement by Lydekker (1898): 'I am informed by a correspondent that, unlike domesticated rams, the male bharal [blue sheep] in the London Zoological Gardens, when charging each other, rise on their hindlegs after the manner of goats previous to the impact'. Aggression was not often seen in the wild because in a situation of potential conflict the smaller of two individuals circumvented the meeting by veering aside or feeding. When, for instance, a class III male approached a class II male at a saltlick, the latter swiftly turned 180° and grazed intensively only to return to his former place as soon as the large male departed. Those aggressive interactions that did occur can be divided into the broadside display, an indirect form of threat which may serve to intimidate an opponent by showing off certain physical attributes, and direct forms of aggression, those that either imply force or threaten the use of it.

Broadside display. An adult male sometimes halted for a few seconds on a prominent spot within the group and stood erect as if showing his fine physique to all members. However, most displays were directed at another and somewhat smaller male. Typically a male presented his broadside while walking slowly past or standing

briefly by the other male. His head was slightly lowered and chin tucked in. The muzzle was often turned slightly away from the opponent, and the tail was at times raised to a horizontal or vertical position. The two animals were either parallel to each other or the displaying one presented himself at right angles. Occasionally a male deviated from his course of travel and cut in front of another one without assuming a special posture, except to walk slowly for a few steps before continuing at a normal pace. Most broadsides were displayed by class III and IV males. The behaviour elicited little response from the threatened animal which continued with its routine though it sometimes turned its head away or fed more intensively.

Horning vegetation. A blue sheep horned a low shrub with vigorous, lateral motions of its head on 6 occasions, 5 of the participants being females and one a class I male. Horning was not shown in a particular social context, and, considering the fact that females were usually involved, the behaviour may not have been a form of redirected fighting, as seems to be sometimes the case among ungulates, 'but a comfort activity with slight social traits' (Krämer 1969).

Jerk and lunge. A blue sheep often jerked down its head at another group member as if to butt. On 7 occasions the gesture was also accompanied by a lunge of a metre or more. Jerking and lunging were the most commonly observed forms of aggression (Table 1),

TABLE 1

FREQUENCY AND KIND OF OVERT AGGRESSION USED BY VARIOUS AGE AND SEX CLASSES OF BLUE SHEEP

Age and sex class	Jerk and lunge	Jump	Butt	Clash ¹	Total number aggressions	No. aggressions per animal-hour of observations
Class IV male	(1)			1	1 (1)	·03 (·50)
Class III male	6 (8)	1	1	1	9 (8)	·14 (·72)
Class II male	(2)				0 (2)	·0 (·33)
Class I male	5		2	1	8 (0)	·12 (0)
Yearl. male	3 (2)	3	3 (1)	8 (1)	17 (4)	·23 (·28)
Adult female	10 (1)		(1)	2	12 (2)	·07 (·08)
Yearl. female				3 (1)	3 (1)	·05 (·08)
Young	1	1 (1)			2 (1)	·01 (·05)

Interactions at a salt lick are tabulated separately in parentheses. The data are based on 634 animal-hours of observation in a normal situation and 89 hours at a salt lick. One animal observed for one hour equals one animal-hour.

¹ Both participants in a clash are tabulated because both behaved aggressively.

usually shown in response to being crowded or in competition for a limited resource. An animal nearly always threatened one smaller

than itself or one of equal size, except that yearling males sometimes jerked their head at adult females. Animals of all ages and both sexes used the jerk, but it was most often directed by class III males at yearling males and by adult females at young (Table 2). The threatened animal quickly retreated.

TABLE 2

AGGRESSORS AND RECIPIENTS IN 53 OVERT AGGRESSIVE INTERACTIONS (EXCLUDING CLASHES) AMONG BLUE SHEEP

Aggressor	Male				Recipient			Young
	Class IV	Class III	Class II	Class I	Yearl.	Adult	Yearl.	
Class IV male							(1)	
Class III male	1	1			5 (3)	1 (3)	(1)	(1)
Class II male							(1)	(1)
Class I male					2	4		1
Yearl. male					3	1 (1)	2 (2)	3
Adult female					1 (2)		2	7
Yearl. female								
Young								2 (1)

Interactions at a salt lick are in parentheses.

Head-shake. Once a class III male was lying down when another class III male walked up and faced him. The former tucked in his chin, then shook his head several times from side to side. This seemingly threatening gesture having no effect, he suddenly rose and lunged at the intruder.

Jump. On 6 occasions one blue sheep reared upright on its hindlegs in front of another, holding its head slightly twisted to one side as if preparing to clash horns. Twice a young jumped up before another young, once two yearling males reared up in unison, once a yearling male threatened a yearling female, and on a final occasion a class III male displayed to a class IV male but was ignored.

Butt. At times a jerk or lunge resulted in body contact—a butt or hook with the horns. The butt landed on the rump on 7 occasions and in the side once. All except one butt were delivered by males, usually by yearling and class I males, and directed mainly at females and young.

Clash. Blue sheep may clash in several ways. Sometimes two animals sparred briefly, twisting their heads while shoving and even circling rapidly with horns locked. The sheep usually faced each other, but occasionally they stood parallel with bodies almost touching as they tussled with their horns. The tail of one or both combatants may

be raised vertically. In such a position, the white hairs at the edge of the tail seem to fan out, making the rump area quite conspicuous. At other times an animal may rear up, take a hop or two on its hindlegs, then lunge at another who merely catches the horn blow with its horns. Occasionally both sheep faced each other, perhaps first taking a few steps backwards, then rearing up on the hindlegs to stand with muzzles twisted sideways and with forelegs either hanging loosely or sharply flexed at the carpal joints. After a moment of hesitation they fell forward in unison to clash horns while their forelegs were still off the ground. Contact may then continue in the form of a brief sparring match. In a variation of this combat method, two animals stood side by side while facing in opposite directions with their shoulders almost touching. Sometimes they circled rapidly before suddenly standing up and, with horns cocked toward each other, plunging sideways to meet with a crash. Immediately both may rear up once more and clash, again and again, as many as 11 times in quick succession. Finally one animal terminates the interaction by turning away, and it may then be lunged at or butted. Yearling males clashed most often, usually with other yearling males or with yearling females; class II, III, and IV males were not involved in clashing, except once when two adults touched horns.

Table 1 lists only 9 instances of clashing, and of these 4 were gentle sparring bouts. But, in addition, I witnessed one general melee lasting 5 minutes during which several animals butted, clashed, and chased each other. The aggressive interactions in this incident were not quantified, and hence not included in Tables 1 and 2, because I was unable to record them all. Partners changed often and sometimes the action moved out of sight behind rock outcrops. There were 15 sheep including 2 class III and a class IV male, in the group that day, but only 3 adult females, 2 yearling females, and 2 yearling males took part in the general fighting which ensued after an adult female and a yearling male clashed. Two vignettes from this lengthy incident are described below:—

(1) A yearling female watched two yearling males first stand on their hindlegs and clash, then tussle on all fours with horns locked. Suddenly she lunged in and butted a male in the rump. He twisted around and sparred with her briefly. As he turned again to face his original partner, the latter reared up quickly and lunged, and he had barely time to catch the blow on his horns.

(2) Several animals trotted around in a compact group when a yearling female, slightly ahead of the others, suddenly turned and reared up in front of the others. These shied aside, and, in turning, one yearling female clashed with a yearling male behind her. She then butted him in the side. A nearby adult female joined the fray, lunging

at the male who returned the attack by crashing his horns against hers.

Table 1 shows that frequency of aggression varied considerably between the age and sex classes. In this table, and in Table 2, I have quantified aggression at a saltlick separately from other circumstances. At the saltlick, which I established and which blue sheep visited on 3 days, the animals were artificially crowded and competed for the salt. This affected their behaviour. Females and young were quite unaggressive. The males, especially the males of classes II and IV, also interacted with a low frequency during their daily routine. But aggression in class II, III, and IV males increased markedly at the saltlick where a large male characteristically appropriated a choice spot and threatened any smaller animal which approached. Yearling males had the highest aggressive rating away from the saltlick and a moderately high one at it.

DISCUSSION

My enumeration of courtship and aggressive displays in blue sheep is undoubtedly incomplete. However, enough of a repertoire was witnessed to make comparisons between *Pseudois*, *Ovis*, and *Capra* instructive. Turning first to courtship patterns, the lip-curl and low-stretch are so widespread among ungulates that their presence in blue sheep was to be expected. Both *Ovis* and *Capra* use the kick, the former a high vigorous one (Geist 1971) and the latter generally a weak one with the foreleg somewhat bent (Walther 1961). Blue sheep kick more like goats than sheep. The males of several species of *Capra* and *Ammotragus* may place their penis into the mouth (Hass 1958; Schaller & Mirza, in press), a behaviour also observed in blue sheep. A similar pattern has not been reported for *Ovis*. A courting *Ovis* male usually does not raise his tail much above the horizontal whereas a *Capra* male may arch it up on the rump. Blue sheep differ from both these genera in that they raise the tail straight up, a position also observed in courting Himalayan tahr (*Hemitragus jemlahicus*) by Schaller (in press).

A broadside display with chin tucked in is found in markhor (*Capra falconeri*) and Marco Polo sheep (*Ovis ammon polii*); and head-shaking as a form of threat occurs in ibex (*Capra ibex*) and Marco Polo sheep (Walther 1961). The jerk, lunge, and butt, as well as the tendency to horn vegetation, can be observed in many ungulates. The presence of these behaviour patterns in blue sheep does thus little to clarify the evolutionary affinities of that species.

Both *Ovis* and *Capra* may rear up on their hindlegs, the sheep standing with body not quite erect and with forelegs extended, and true goats wholly upright with forelegs flexed. Blue sheep jump up